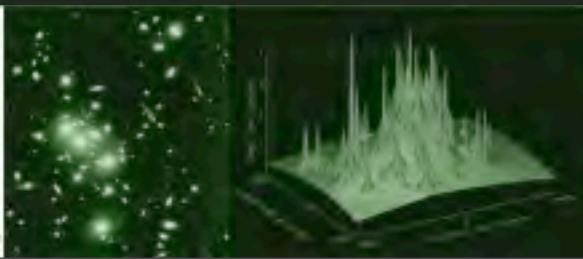
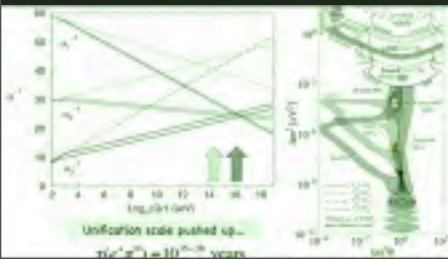
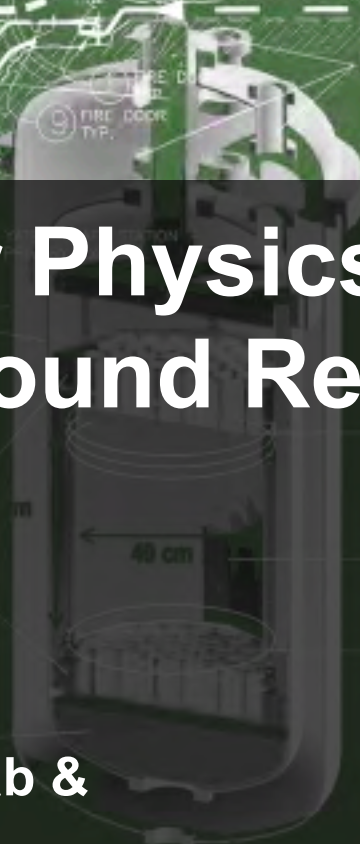


Intensity Frontier Physics Research at the Sanford Underground Research Facility

November 30, 2011

Kevin Lesko

Lawrence Berkeley National Lab &
UC Berkeley

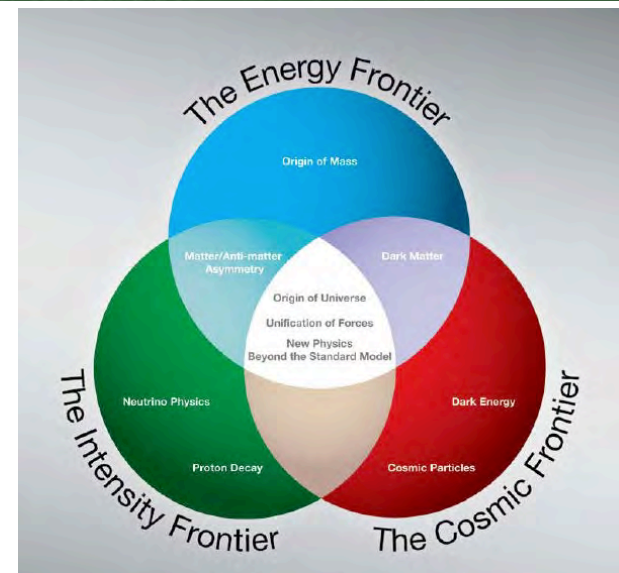


Outline - Homestake and the Intensity Frontier

- Intensity Frontier and Underground Physics Opportunities
- Status of the Facility and near-term Activities
 - SURF's mission and focus
 - Facility maintenance, rehabilitation and improvements
 - Early science program
- SURF Science Programs and a longer-term vision
 - Long-baseline Neutrino Experiment + Proton Decay
 - 2nd & 3rd generation Dark Matter and Subsequent Neutrinoless Double Beta Decay Experiments
- Questions and Discussion

2008 Particle Physics Project Prioritization Panel (P5) Report

- The panel recommends a world-class neutrino program as a core component of the US program, with the long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab.*
- Subsequent HEPAP Reports reaffirm this recommendation and emphasize the critical importance of maintaining a vital and healthy domestic program
- Neutrino Program using Fermilab's neutrino beam aimed at Homestake represents the flagship experiment for the domestic program
 - CP violation
 - Neutrino Oscillations and Properties
 - Proton Decay
 - Ancillary Measurements of and with Neutrinos



National Research Council Assessment: Profound Science

- *Three underground experiments to address fundamental questions regarding the nature of dark matter and neutrinos would be of paramount and comparable scientific importance:*
 - The direct detection dark matter experiment,*
 - The long baseline neutrino oscillation experiment, and*
 - The neutrinoless double-beta decay experiment.*
- *Each of the three experiments addresses at least one crucial unanswered question upon whose answer the tenets of our understanding of the universe depend.*

National Research Council Assessment: Science Hosted Domestically and Fostering US World-wide Leadership

- The co-location of the three main underground physics experiments at a single site would be a means of efficiently sharing infrastructure and personnel and of fostering synergy among the scientific communities. The infrastructure at the site would also facilitate future underground research, either as extensions of the initial research program or as new research initiatives. These added benefits, along with the increase in visibility for U.S. leadership in the expanding field of underground science, would be important considerations when siting the three physics experiments.*

Vision Commensurate to the Science: *Marx/Reichanadter Report*

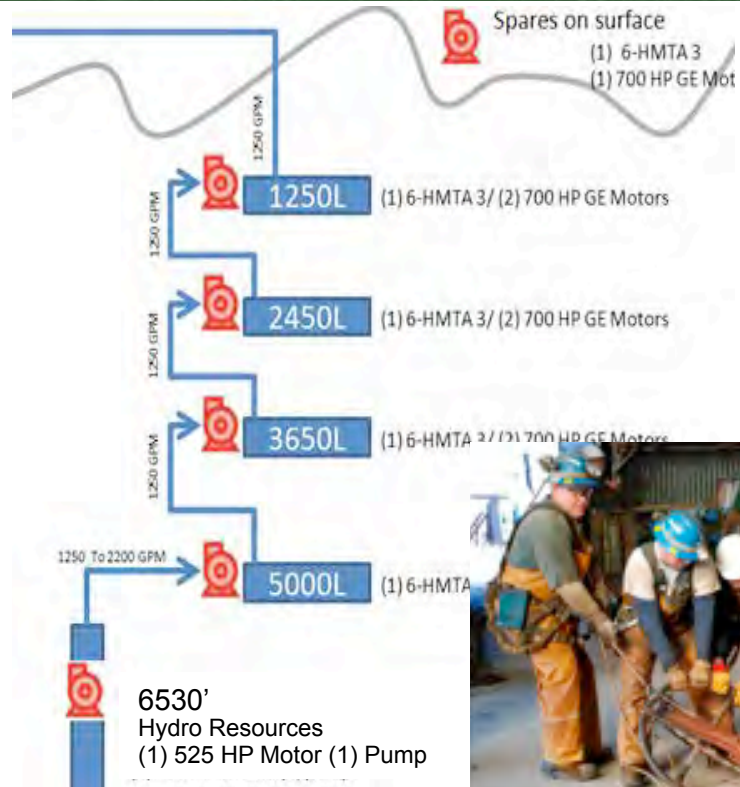
- *The time needed to carry out the three experiments will extend over two decades or more from now, including about one decade before data taking begins*
 - *In each case it is quite likely that there will be upgrades and follow-on experiments that will further extend the time scale of these physics programs*
- *That noting the scale of investment and time scales for these experiments that there major advantages to developing a common underground site for these experiments:*
 - *sharing infrastructure and coordination of design, construction, management and operations*
 - *training of next and subsequent generations of scientists and engineers*

Sanford Underground Research Facility (SURF)

- Customized facility to address DOE's three underground research areas: Dark Matter, Neutrinoless Double Beta Decay, and Long-Baseline Neutrinos (DM, DBD, LBNE)
 - using 4850L or perhaps 800L
- Facility ownership and operations organization are established
 - dedicated science facility
 - no competition and associated risks from mining, transportation, or tourism
 - well assessed facility and low risk: just completed the NSF's PDR with full assessments and plans for a much more comprehensive facility
 - much of PDR design is applicable to LBNE
 - LBNE using PDR A/E Design Contractors
 - as well as planning for G3 DM and 1-tonne scale DBD experiments
 - facility design is readily expandable and adaptable
 - customized designs for modern experimental requirements
- Facility improvements & enhancements underway
- Initial (early) science program underway
 - Integration and Oversight of Science Program and Facility



Facility Maintenance and Dewatering Activities



– SURF maintaining key infrastructure on the Surface and Underground

- Redundant Safe Access
- Ventilation
- Utilities
- Pumping accumulated water

– Water treated and disposed in local stream meeting EPA regulations and monitoring requirements

– Water level on November 25 below 5724-feet rapidly gaining depth

Access to the 4850L obtained with Independent Shafts and Conveyances - Ross and Yates

◆ Ross Shaft – for Construction and Maintenance Activities

- Design for Shaft Steel Furnishings Rehabilitation and Other Improvements
 - Complete steel replacement, new bearing beams, ground support
 - Initial \$7.5M in materials from Sanford Gift
 - Entering Final Design – Aug 2010
 - General Arrangements – Oct 2011
 - Construction Start – Nov 2011
 - Scheduled Completion – Dec 2014

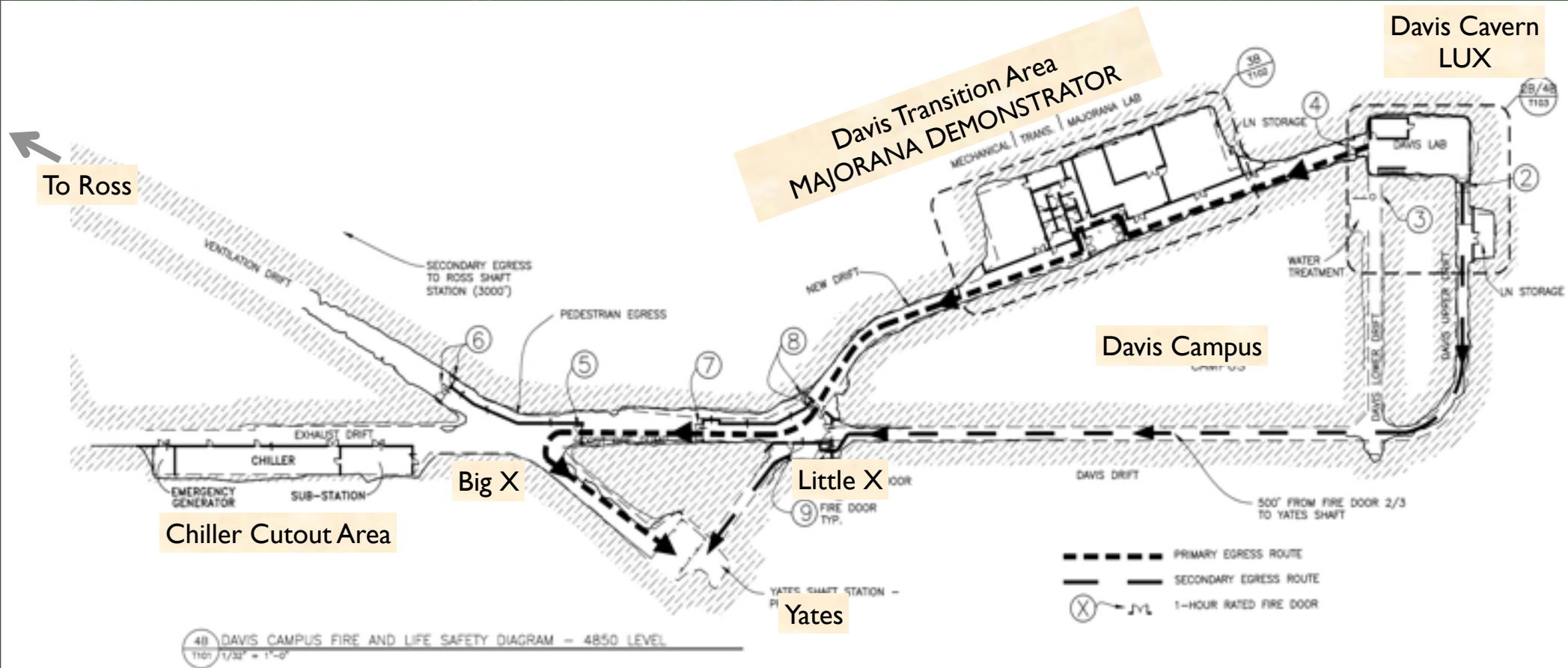


◆ Yates Shaft – rehabilitate for Primary, Redundant Access

- Wooden shaft furnishings regularly maintained
 - Design for new emergency braking system complete
 - New Wire Ropes procured,
new “cage” procured & installation underway
 - Bids for Construction received: November 2011
 - Contract for steel fabrication awarded, underway
- Foundations: November - December 2011
- Steel erection: February - March 2012

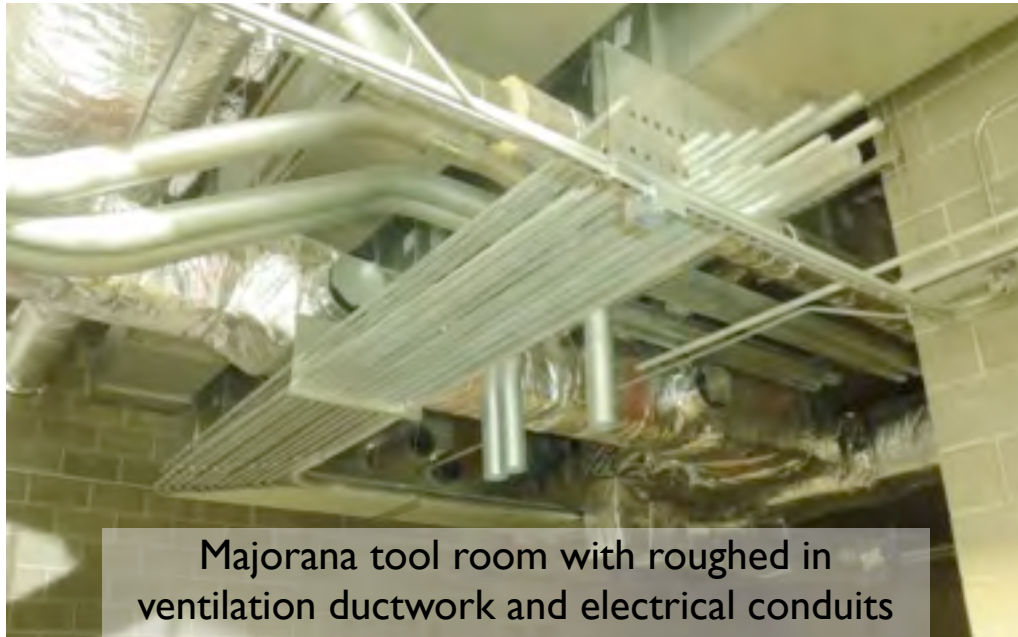


Davis Campus Supporting Early Science - the Sanford Laboratory



- Highpoint of South Dakota's \$120M Investment
- On budget and on schedule for March 22, 2012 beneficial occupancy
 - LUX Dark Matter Experiment
 - MAJORANA DEMONSTRATOR Neutrinoless Double Beta Decay

Davis Campus Outfitting



Majorana tool room with roughed in ventilation ductwork and electrical conduits



Last two sections of concrete poured for the chiller room floor



Structural steel installed for counting room roof



Outside wall of mechanical room completed

Davis Campus Outfitting



Freshly poured concrete at the little X



Poured backing bolt supports for structural steel inside the Davis Caver



Additional ductwork installed in transition area

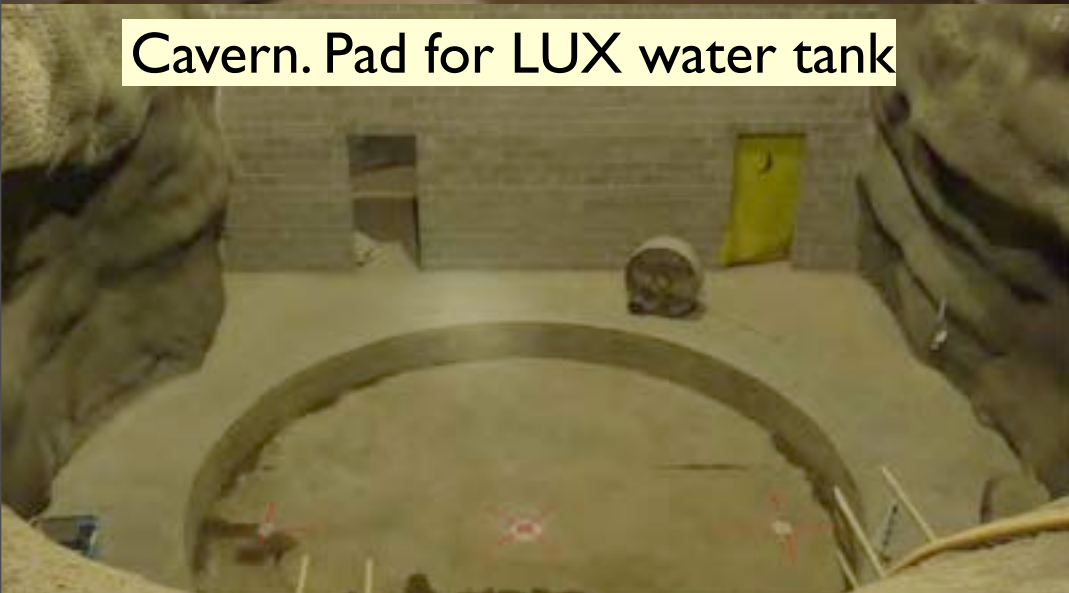


Ductwork inside connecting drift between the Davis Cavern and transition area

Davis Campus Outfitting



Cavern. Pad for LUX water tank



Transition Area. Infrastructure for MJD



MAJORANA DEMONSTRATOR

- Electroforming clean room near Ross shaft



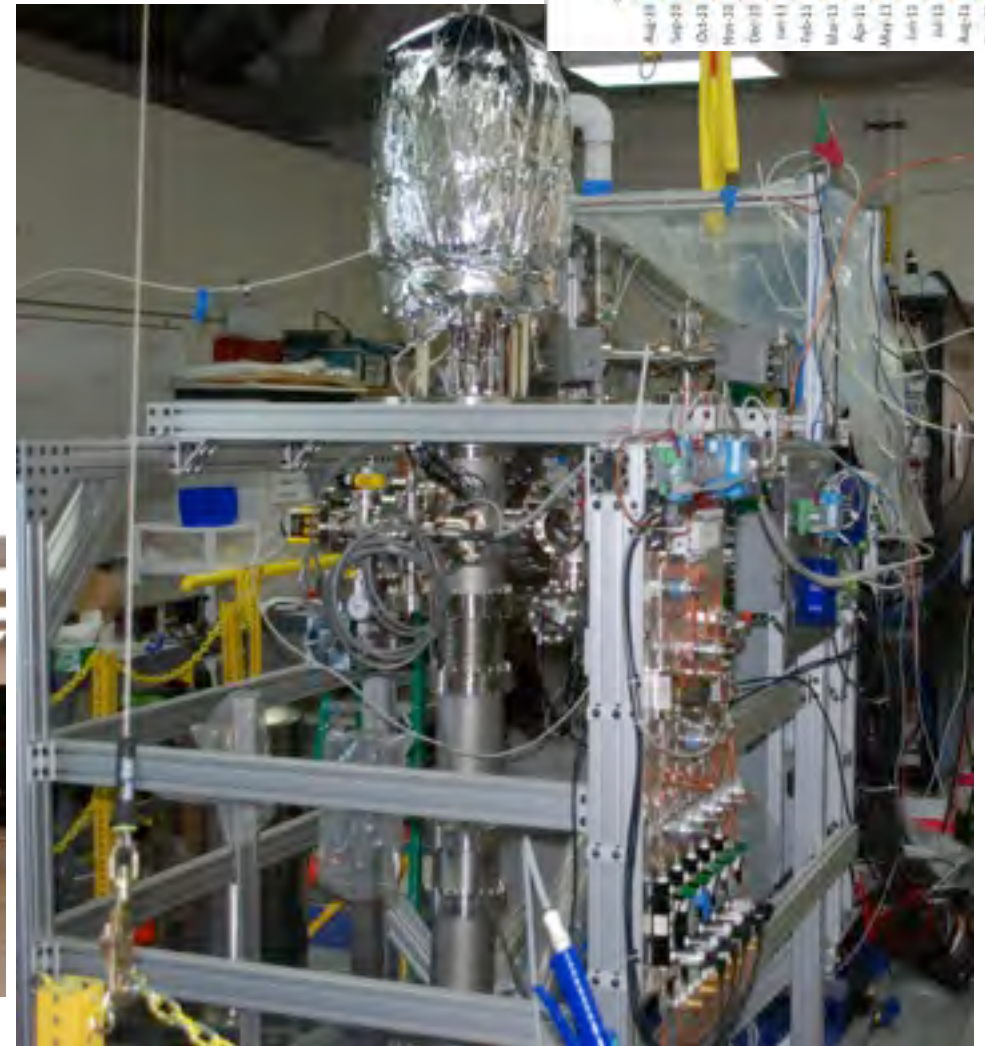
LUX Dark Matter



LUX Collaboration meet at Sanford on October 22 – 23, 2011



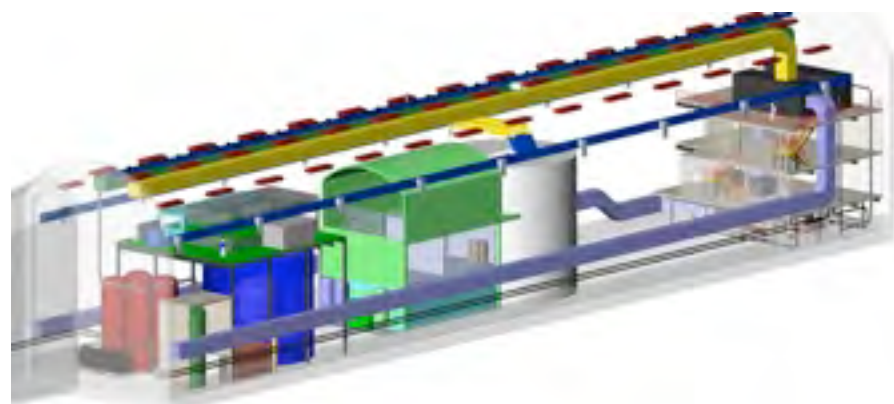
LUX Underground Readiness Review held at Sanford on October 24 – 25, 2011



Thermosyphon Dewar Prior to Outer Can Installation

SURF Science Programs

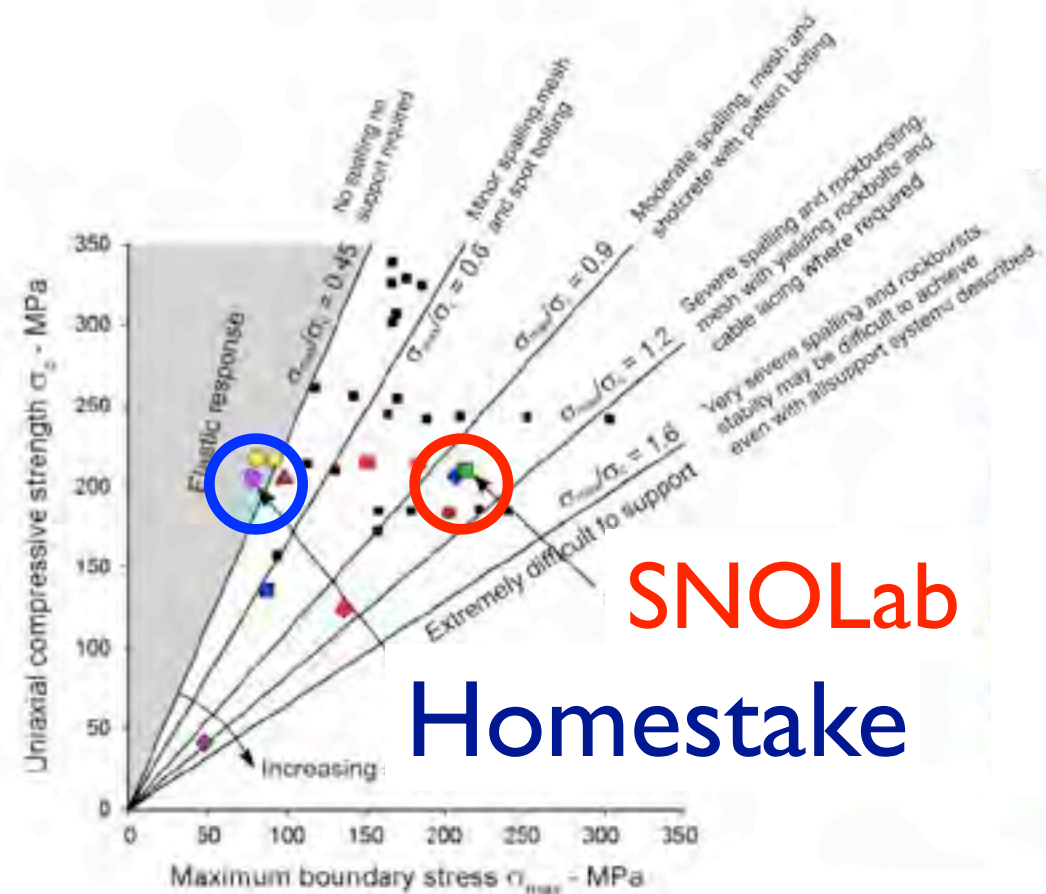
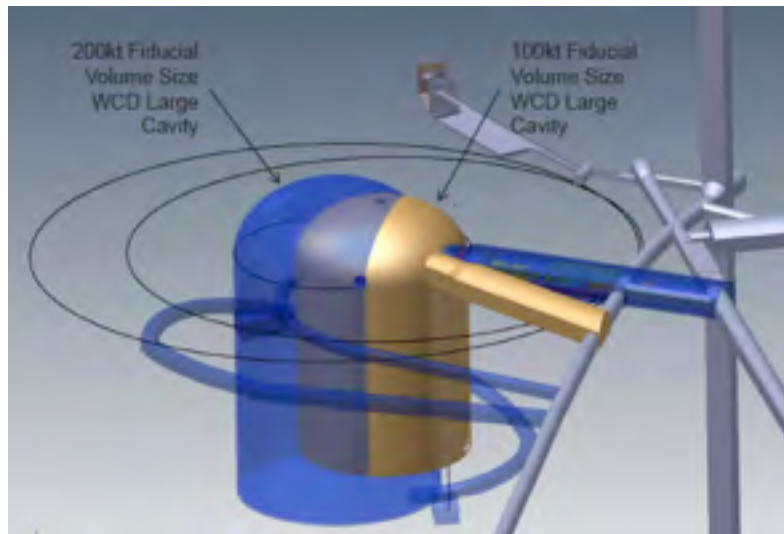
- Establish, support and maintain world-class programs in:
 - Dark Matter
 - G1 in Sanford Lab (LUX)
 - G2 experiments to be hosted in Sanford Lab
 - G3 in a new Lab Module
 - Neutrinoless Double Beta Decay
 - G1 in Sanford Lab & Electro-forming Lab (MAJORANA DEMONSTRATOR)
 - On-going material generation, assay and prototyping
 - One tonne-scale experiment in a new Lab Module
 - Long Baseline Neutrinos, Proton Decay, and ancillary neutrino measurements
 - 4850L WCD, LAr or 800L LAr
 - Support LBNE in developing facility infrastructure for the experiment and associated R&D



Large Cavities within Homestake for LBNE

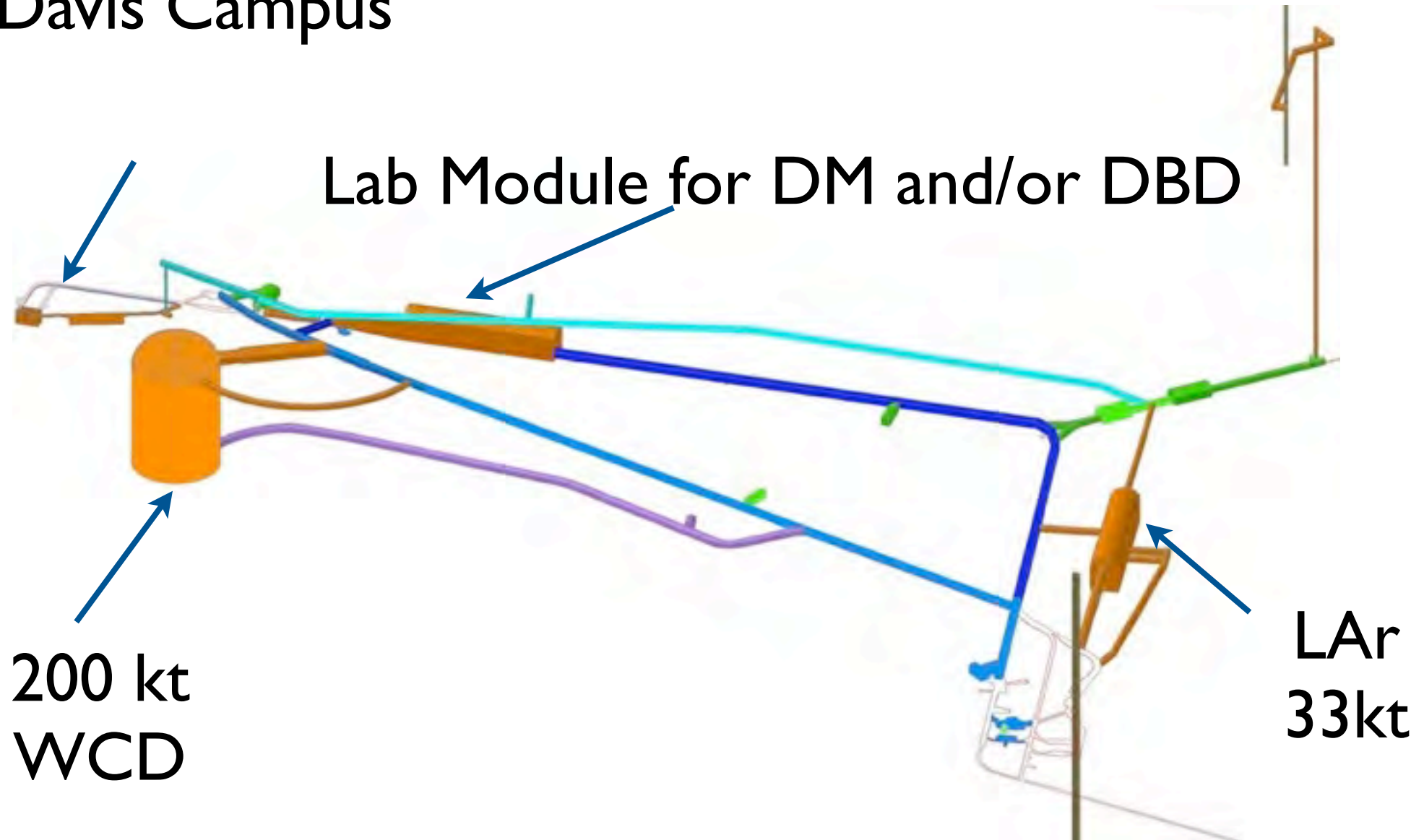
- A combination of favorable rock mass strength and structural conditions and an in situ stress field that is reasonably benign means that a stable 66 m diameter 102 m high vertical cylindrical cavern can be constructed at the selected location on the 4850 level of the Homestake mine.*

LCAB May 2011

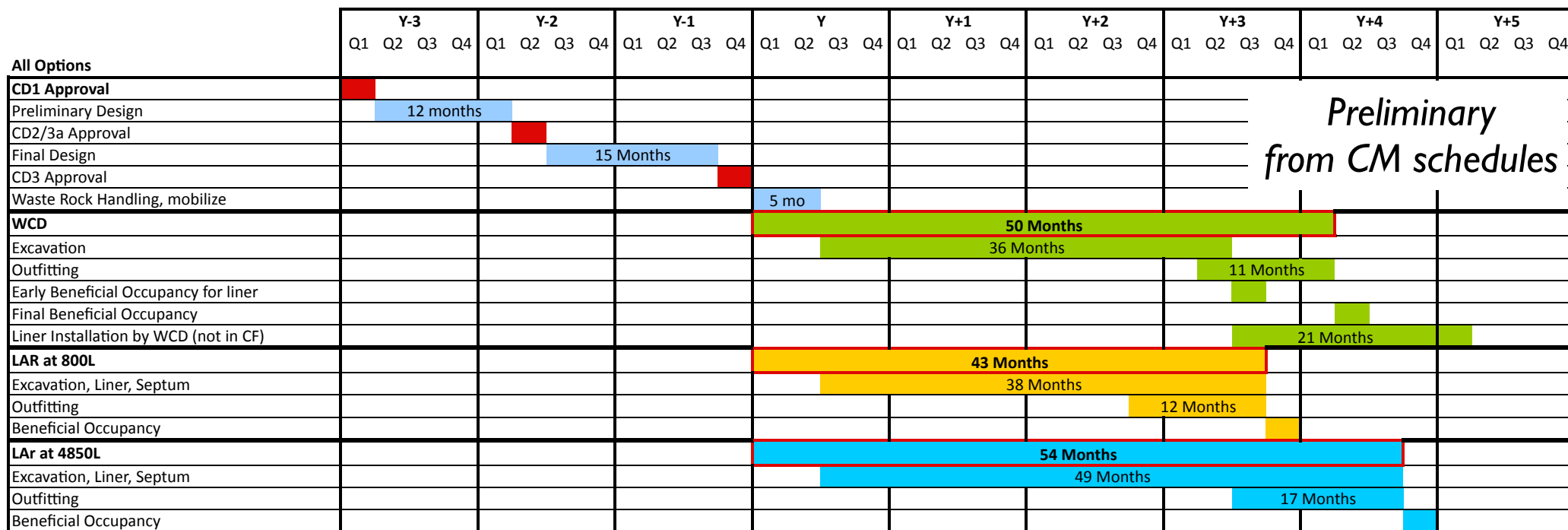


Long-Baseline Neutrinos, Dark Matter and Neutrinoless Double Beta Decay at 4850L

Davis Campus



Science Timelines at SURF



- The “Plan B” Lab module excavation schedule shorter than LBNE’s excavation ~ 2 years from Plan B schedule
- The Lab Module, if executed simultaneously, would add ~ \$100M to \$150M depending on cost-sharing model
- Analyses of Plan B design and costs consistent with other facilities providing equivalent codes, volumes and services

Summary

- Homestake site & SURF

- Low-risk, well-assessed site for DOE's missions
- Significant preparation work and design work completed, at a Preliminary Design Level, much of this applicable to DOE-run facility for Physics
- Science program established at SURF and provides a path for significant results while community assesses LBNE, next generation Dark Matter and Neutrinoless Double Beta Decay roadmaps and plans
 - Generation 1 Dark Matter and Neutrinoless Double Beta Decay initiated, support for this Early Science Program by Office of Science
 - Generation 2 Dark Matter could be hosted in existing facilities at the 4850L
 - Lab Module at 4850L could host both Generation 3 Dark Matter and 1-tonne Neutrinoless Double Beta Decay experiments and maximize the synergisms with LBNE
- Efficient and stable operations, maintenance, EH&S programs and organizations